Bone Injection Gun placement of intraosseous needles

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Abstract
A short cut review was carried out to establish whether the Bone Injection Gun is better than a standard intraosseous (IO) needle at obtaining IO access. A total of 129 papers were found using the reported search, of which three represent the best evidence to answer the clinical question. The author, date and country of publication, patient group studied, study type, relevant outcomes, results and study weaknesses of these best papers are tabulated. A clinical bottom line is stated.

Clinical scenario
A 23 year old shocked patient is brought to into the Emergency Department resuscitation room. The trauma team are trying to gain vascular access. After five minutes of being unable to gain intravenous access you remember a recent training session on a Bone Injection Gun (BIG) and you wonder if this would be better to use than the standard IO needles that you have previously used?

Three part question
In [patients requiring IO access] is [the Bone Injection Gun better than standard IO needles] at [safely and rapidly acquiring IO access]?

Search strategy
Medline 1966-01/05 using the OVID interface. [exp Infusions, Intraosseous OR intraosseous infusion$.mp OR intraosseous.mp OR IO.mp] AND [BIG.mp OR auto-injector.mp OR auto$.mp OR bone injection gun.mp] LIMIT to English

Search outcome
Altogether 129 papers were found, of which three were relevant to the three part question.

Comment(s)
There are no published studies looking at the use of the BIG in live adults or children. Though this would be ideal it is unlikely to be achievable as IO placement is a rare event and there would be ethical and consent issues. We must therefore extrapolate data from other models. The paper by Calkins *et al* shows that the technique itself is easy to learn by non-medical trained responders, this may have implications for its use in prehospital care. This paper also used the screw tipped IO needle as the standard needle but in practice people may be more used to the standard straight needle. Waismann and Waismann suggest that they can be used succesfully in practice. Olsen found a higher failure rate in anaesthetised dogs but explained this was due to poor landmark identification rather than device failure. The differences in time to placement are unlikely to be clinically significant. From a clinical perspective there appears to be little to choose between them and issues such as cost and training may influence local decisions.

► CLINICAL BOTTOM LINE
The Bone Injection Gun appears to be equivalent in terms of success and possibly (but not clinically significantly) faster to use than standard IO needles at achieving IO access.

Calkins MD, Fitzgerald G, Bentley TB, Burris D. Intraosseous infusion devices: a comparison for potential use in special operations *J Trauma* 2000;**48**:1068–74.
Waisman M, Waisman D. Bone marrow infusion in adults *J Trauma* 1997;**42**:288–93.
Olsen D, Packer BE, Perrett J, *et al*. Evaluation of the bone injection gun as a method for intraosseous placement for fluid therpay in adult dogs. *Veterinary Surg* 2002;**31**:533–40.

Nebulised levalbuterol or albuterol for lowering serum potassium

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Abstract
A short cut review was carried out to establish whether nebulised levalbuterol is better than or equivalent to albuterol

Table 2

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Calkins MD *et al*, 2000, USA	31 special operations corpsmen testing 4 IO devices on cadavers; BIG, screw tip IO needles (2 other devices not relevant to the three part question so results not given)	Randomised experimental trial	Success rate	BIG 94%, screw tip 97% (not significant)	Using non-medical responders. By using cadavers there is no ''clinical pressure'' to achieve vascular access
			Time to placement	BIG 70 s (SD 33), screw tip 88s (33) (not significant)	
			Rank of preference (1–4)	BIG average rank 2.3, screw tip average rank 2.5 (not significant)	
Waisman M and Waisman D, 1997, USA	19 patients for resuscitation in whom IV access could not be achieved within 10 minutes and 31 adults with fractures receiving regional anaesthesia	Prospective case series	Success rate	100% successful placement	Observational study with no comparisons. Small numbers. Lack of follow up in resuscitation group
			Time to placement	Time taken ''1–2 minutes''	
			Complications	None in 24 hours or 4 months for respective groups	
Olsen D, 2002, USA	Adult dogs randomised to either IO gun or a Jamshidi IO needle; 24 dogs in each group	PRCT (animal)	Successful placement	20/24 (83%) for BIG *v* 23/24 (96%) for the Jamshidi; p=0.3475	Animal study. Anaesthetised subjects. Direct relevance to humans questionable. Single operator did all procedures. They explain increased failure rate for BIG to be due to poor landmark identification rather than device failure
			Average time for placement	22.4 s for BIG *v* 42 s for Jamshidi	

Table 3

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Lipworth BJ *et al*, 1997, UK	12 volunteers were randomised into 4 study groups: nebulised R-albuterol (200–3200 μg), S-albuterol (200–3200 μg), RS-albuterol (400–6400 μg) or placebo	PCRT crossover	Pharmacodynamics at extrapulmonary β2 receptors (tremor, plasma potassium, heart rate) measured at 0-100 minutes at 20 minute intervals	No significant differences were found in baseline plasma potassium values (no p values provided)	Small doses of study drugs used in healthy volunteers Small sample size Mean age (20.6) may not be representative of majority of population presenting with hyperkalaemia
Gumbhir-Shah K *et al*, 1999, USA	13 asthmatic subjects randomised to receive four cumulative doses of either nebulised 1.25 mg levalbuterol or 2.5 mg albuterol at 30 minute intervals	RCT crossover	FEV_1, plasma potassium, plasma glucose, heart rate, QTc interval, and urine plasma drug concentration at 1, 2, 4, 6, 8 hours after final dose	No significant difference between R and RS albuterol in reduction of plasma potassium levels (AUC p=0.17)	Four consecutive small doses given at 30 minutes intervals may not be applicable to those patients presenting with pathological hyperkalaemia Small sample size
			Side effects	None severe. Included dizziness, tachycardia, nervousness (greater in R group), wheezing (greater in RS group). All events resolved spontaneously	
Lotvall J *et al*, 2001, Sweden	20 adult asthmatic patients were randomised into 4 study groups: nebulised R-albuterol (6.25–1600 μg), S-albuterol (6.25–1600 μg), RS-albuterol (12.5–3200 μg), or placebo	PCRT 4-way crossover	FEV_1, heart rate, and plasma potassium levels before dosing FEV_1, heart rate and plasma potassium levels 20 minutes after each dose	Differences/p values not documented Rapid increase in plasma potassium level (0.3–0.4 mmol/l) after placebo administration (no p value given)	Single K^+ level was measured 20 minutes after study drug Small sample size The dose of albuterol required to reverse hyperkalaemia is higher than standard bronchodilator doses used in this study
			Side effects	No serious adverse events and majority of adverse events were reported after treatment with R or RS albuterol. These included tremor, palpitations, and tachyarrhythmias	
Pancu D *et al*, 2003, USA	27 healthy adult volunteers; 9 nebulised normal saline, 9 albuterol (10 mg), 9 levalbuterol (2.5 mg)	Randomised, double blind, placebo controlled trial	Serum potassium values at baseline	No difference between any group: albuterol 3.9 (0.3) mEq/l, levalbuterol 4.1 (0.3) mEq/l, placebo 4.1 (0.3) mEq/l	This study measured potassium changes in a small sample of healthy volunteers. The clinical significance of these small changes in potassium is uncertain and these changes may not be applicable to those patients presenting with pathological hyperkalaemia. Objective vital signs were only recorded in those patients reporting side effects
			Serum potassium at 30 minutes	Albuterol reduced by 0.3 mEq /l; levalbuterol reduced by 0.3 mEq/l; placebo increased by 0.1 mEq/l; no significant difference between β agonists. Both β agonists better than placebo (p=0.005)	
			Serum potassium at 60 minutes	Albuterol reduced by 0.3 mEq /l; levalbuterol reduced by 0.5 mEq/l; placebo showed no change. No significant difference between β agonists. Both β agonists better than placebo (p=0.001)	
			Side effects	Levalbuterol caused fewer reported side effects than albuterol. Levalbuterol *v* albuterol: total percent reporting symptoms, 22% *v* 78%; tremor, 22% *v* 78%; nervousness, 0% *v* 56%; palpitations, 0% *v* 56%; tachycardia, 0% *v* 44% No p values provided	

for lowering serum potassium. Seven papers were found using the reported search, of which three presented the best evidence to answer the clinical question. The author, date and country of publication, patient group studied, study type, relevant outcomes, results and study weaknesses of these best papers are tabulated. A clinical bottom line is stated.

Three part question

In [patients with hyperkalaemia] is [levalbuterol better than albuterol] at reducing [serum potassium]?

Clinical scenario

A 67 year old man presents to the emergency department with chest pain and syncope. The electrocardiogram shows a wide QRS and peaked T-waves. Stat electrolytes show a potassium level of 7.3. While starting calcium gluconate, glucose/insulin, nebulised albuterol and kayexelate you wonder if substitution of levalbuterol for albuterol would have the same lowering effect on serum potassium and have fewer side effects.

Search strategy

Medline 1966–October 2004 using the OVID interface. [levalbuterol.mp or exp Albuterol/OR (albuterol or salbutamol).mp OR exp bronchodilator agents/OR exp adrenergic beta-agonists/OR beta-agonists.mp] AND [exp stereoisomerism/OR enantiomers.mp OR racemic.mp] AND [hyperkalemia.mp. or exp hyperkalemia/OR hyperkalaemia.mp OR exp potassium] LIMIT to human AND English language

Search outcome

Seven papers were found of which three were irrelevant to the study question. The remaining four papers are shown in table 3.

Comment

Equipotent nebulised levalbuterol appears to be as effective as albuterol in lowering serum potassium in healthy and asthmatic adults. Studies comparing these two medications in hyperkalaemic patients with comorbidities and on various medications would be helpful in establishing their comparative efficacy in treating common presenters to the emergency department.

► CLINICAL BOTTOM LINE

Nebulised levalbuterol appears to be as effective as albuterol in lowering serum potassium in adults.

Pancu D, LaFlamme M, Evans E, *et al*. Levalbuterol is as effective as racemic albuterol in lowering serum potassium. *J Emerg Med* 2003;**25**:13–16.
Lotvall J, Palmqvist M, Arvidsson P, *et al*. The therapeutic ratio of R-albuterol is comparable with that of RS-albuterol in asthmatic patients. *J Allergy Clin Immunol* 2001;**108**:726–31.
Lipworth BJ, Clark DJ, Koch P, *et al*. Pharmacokinetics and exrapulmonary B2-adrenoceptor activity of nebulized racemic salbutamol and its R and S isomers in healthy volunteers. *Thorax* 1997;**53**:849–52.
Gumbhir-Shah K, Kellerman DJ, DeGraw S, *et al*. Pharmacokinetics and parmacodynamics of cumulative single doses of inhaled salbutamol enantiomers in asthmatic subjects. *Pulm Pharmacol Ther* 1999;**12**:353–62.